Paper No. "N"

RECIRCULATING IRRIGATION WATER 1/

By

P. E. Fischbach and J. A. Bondurant 2/

Recirculating irrigation runoff water is a method of making more effective use of irrigation water. Reuse of runoff water decreases the amount of water that needs to be pumped or delivered and can be used to improve water application efficiency. It also reduces the possibility of pollution of natural streams from irrigated land. Other benefits are reduced surface drainage costs, improved weed control and the saving of irrigation labor. Reuse systems are readily adapted to automation and can be used advantageously in modern labor-saving, automated and semi-automated irrigation systems.

The economic value of runoff water will usually be the deciding factor in installing a recirculating irrigation system. However, in some areas runoff may be prohibited by law and recirculation is then mandatory. Where water is relatively expensive, such as water pumped from wells or where the supply is limited, reuse of runoff water may result in a more economical irrigation operation. Reuse of irrigation runoff water may be more economical than the use of additional labor to accomplish efficient irrigation by surface methods. Where runoff water is recycled, most of the diverted or pumped irrigation water will infiltrate the soil.

A reuse system enables the irrigator to use the maximum allowable stream flow in each furrow. Using maximum allowable stream size can result in larger yields and higher irrigation efficiencies (over 90%) than using furrow or border

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2/ P. E. Fischbach, Professor, Agricultural Engineering Department, University of Nebraska, Lincoln, Nebraska, and J. A. Bondurant, Research Agricultural Engineer, SWCRD, ARS, USDA, Kimberly, Idaho.

streams that are too small (3). Large streams move the water through the field rapidly and store water in the furrows or on the border for the lower end of the field after the water has been shut off at the upper end. However, a non-cutback, maximum allowable furrow stream produces 20% to 30% total runoff but also provides more uniform penetration of water throughout the run (3). Therefore, larger streams enable efficient distribution and use of water which in turn results in higher yields. The labor for cutting back furrow streams can also be eliminated when the reuse system is used. Runoff water stored in a sump can be pumped to increase the incoming water supply during the advance period of an irrigation and reuse stopped after the field begins to produce runoff, resulting in a cutback furrow stream (1).

Fertilizers are often applied through the irrigation system. With surface irrigation systems, water must be applied at a rate higher than the soil intake rate in order for it to flow across the field. Since some runoff is unavoidable with most surface systems, many irrigators have been reluctant to apply fertilizers in the irrigation water. However, if a reuse system is used, added fertilizer carried off a field in the irrigation water is collected and put back onto the field or onto an adjacent field.

Components of a Reuse System

A reuse system consists of drains to intercept and carry the runoff to a sump, dugout or pond; a pump, power unit and controls, and pipes to convey the water back into the main irrigation system or to another field.

Storage Reservoirs

The storage reservoir is one of the major components of a reuse system. It may consist of a small sump (Figure 1), a dugout (Figure 2), or a dam and pond (Figure 3). A sump or small reservoir, as shown in Figure 1, is usually constructed when the runoff water is pumped directly back into the main irrigation system. It lends itself best to automated surface irrigation systems but can be and is also used in manually operated surface irrigation systems. However, automatic water level controls should be used to avoid excessive labor requirements with the small storage reservoir. Peak runoff water inflow may be a critical design feature. In many cases, a minimum pumping capacity of 35%

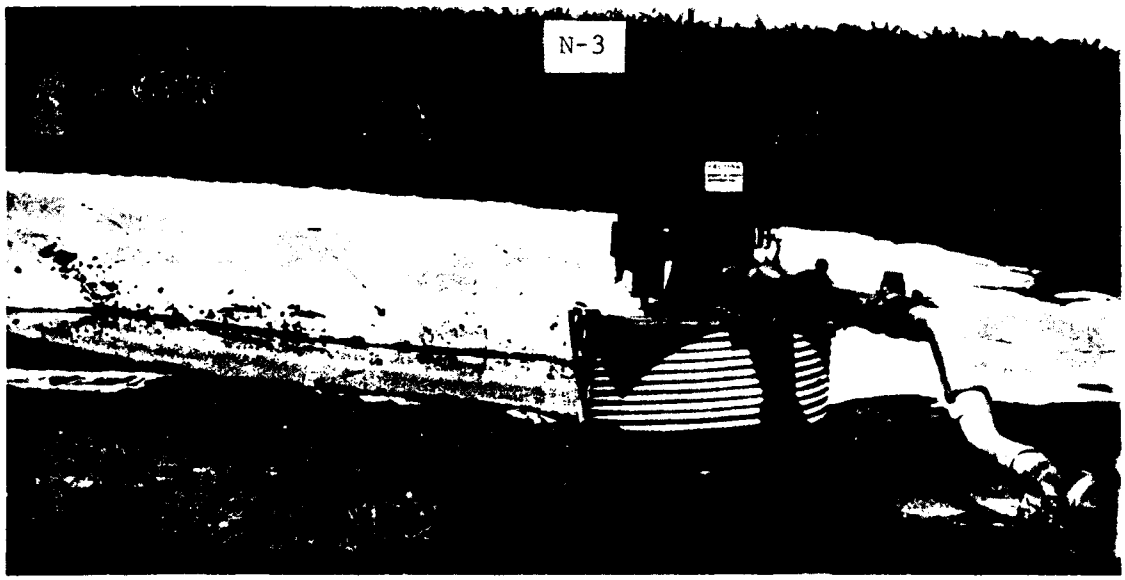

Figure 1. Small sump with reuse pumping plant. Water level controls are used to make it automatic. Reuse water being pumped back into the same field.

Figure 2. A dugout with a centrifugal reuse pumping plant. Runoff water being pumped back into the same field.

Figure 3. A dam and pond used to catch runoff water. Reuse pumping plant used to irrigate another field.

of the main irrigation source is required. These systems should be designed to cycle a maximum of 15 times per hour (4) to prevent motor overheating. This determines the minimum sump size. Small sumps are used when land values are high, large areas of water ponding are undesirable, or if the runoff water is used to effect cut-back stream on the next irrigation set.

Dugouts are another common type of storage for water reuse systems. Most dugouts are about 10 feet deep with 2 to 1 side slopes and may catch and store water from several irrigation sets. Enough water stored in the dugout for one irrigation. The runoff water may be applied to the same or a nearby field. In designing this type of reuse system, the amount of runoff water determines the needed dugout capacity. The pumping plant is selected to utilize the stored runoff water. Surface drainage or emergency drains (spillways) should be provided for the sump and dugout storage systems.

Dams and large ponds provide low cost storage but are limited to locations having favorable topography and substrata formations for dam construction. On the other hand, dams can be located some distance from the irrigated field and the runoff water can be used to irrigate a nearby field which is impractical to irrigate from the main water supply. Runoff water from both rainfall and irrigation can be stored for reuse. Ponds vary in size and range from capacity to irrigate one set to several days' supply. Reuse pumps should have a minimum flow capacity of 25% of the main irrigation water source for both the dugout and pond type storage reservoirs. The pump should develop enough lift to overcome the elevation difference and friction losses in the return pipelines to the fields.

Reuse Pumping Plants

Single stage reuse type turbines, low lift centrifugal, submerged centrifugal, self-priming centrifugal, or sump pumps are used in reuse systems. The electric driven, single stage, reuse type turbine pump makes a convenient pumping plant (1) and an over-all efficiency of 60% or more is easily attained. If the reuse pumping plant is automated with water level controls, absolute fail-safe priming is necessary. Reuse pumps are also powered by internal combustion engines.

Desilting Basins

Although surface irrigation is recommended onslopes that do not exceed 1-1/2%, many surface irrigation systems are operating today on steeper slopes. Usually, but not always, some erosion takes place on these steeper slopes causing a silt problem. The irrigator may have too long a run for his particular slope requiring a stream size that causes some erosion. Reuse systems operated under these conditions probably will require a desilting basin prior to the storage pond, dugout or sump. These desilting basins may need to be cleaned each year of oftener with the soil being hauled back onto the field.

Desilting basins may not be needed if reuse systems are installed with surface irrigation systems on 1-1/2% slopes or less. Most 1-1/2% slopes will allow a furrow stream of about 7 gallons per minute without causing erosion. Soils with a basic intake rate of 0.3 gallon per minute per 100 foot of furrow could have an irrigation length of runoof about 1200 feet (higher intakes will require shorter lengths of runs). The initial stream size could be 0.6 gallon per minute (2 times basic) per hundred foot of furrow and be below the erosive furrow stream size (2). On slopes of 0.2%, furrow streams of 50 gallons per minute can be used without causing serious erosion. Under these conditions surface irrigation length of runs could be one-half mile long on the silty clay loam soils with a clay pan and desilting basins should not be needed. Each surface irrigated area will probably need some special design features.

Trash Screens

All reuse systems probably will need trash screens of some kind. Residue, especially during the first irrigation, is picked up and carried with the runoff water. On some fields this will be a minor problem while on other fields this may be a major problem. For example, fields planted to corn by the Nebraska till-plant system usually have ground up corn cobs or pieces of residue in the runoff water. Therefore, runoff water needs to be screened prior to entering the reuse pump intake. Two types of screens are common in Nebraska. One type is a rotating suction line screen. This screen has a propeller inside the intake of the screen which causes the screen to rotate when water is flowing through it. These can be easily used on centrifugal pumps. The other type, made from hail screen, is about 18 inches in diameter and about 3-1/4 to 4 feet high. The screen

is mounted upright with the bottom end directly connected to the small sump. A 3-1/2 to 4 feet depth basin or lined trench is required to make it operate satisfactorily. The residue floats on top of the water, allowing the water to flow unrestricted into the lower portion of the screen.

Drop Structures, High Velocity Chutes and Protective Dikes

The sump or dugout type of storage reservoir needs some means of controlling erosion as the water from the drainage ditch enters the storage reservoir. For some sump-type installations which are constructed of concrete, concrete block, steel casings, etc., the trash screen is attached to the structure and no added drop structure is needed. However, all earth sumps and reservoirs need some structure to prevent serious erosion of the inlet to the reservoir. Most any type of drop structure or high velocity chutes work well.

A dike should be constructed around the reservoir to protect it from flood damage due to rainfall or melting snow.

Water Level Controls

Reuse systems are easily adapted to automatic controls. Automatic controls are generally of two types:

1. Water level controls in the storage reservoir
2. Time controls.

Water level controls are either air-cell gage-switches, float operated switches, or electrode sensors. The air-cell gage-switches utilize an air cell located near the bottom of the reservoir connected to a water-level gage switch. The high or low water level contacts are adjustable to make the pumping plant start or stop at preset water levels in the reservoir. The float operated switch turns the reuse pumping plant on and off by the water level float activating a mechanical switch. The electrode sensors use the water as a conductor in the circuit. Time controls (clock operated) are sometimes used on the dugout or larger type reservoirs to turn the reuse pumping plant on and off, or off after an irrigation set has been completed.

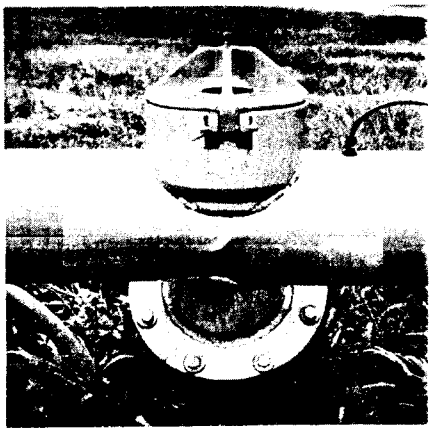

Figure 4. Vacuum relief valves protect the pipe line when the system shuts down. It allows air to enter the pipe line so a vacuum is not created in it. These are located at the high points of the systems.

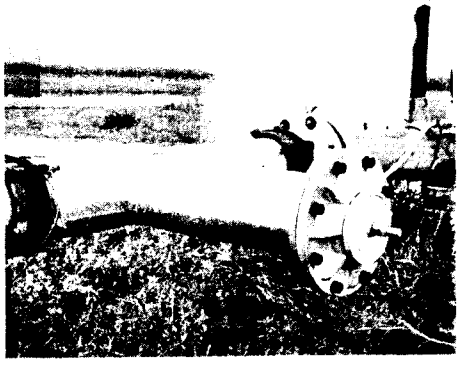

Figure 5. Pressure relief valves protect the pipe line from sudden surges of pressure which usually occur when the pumping plants are started or if a long pipe line is shut down.

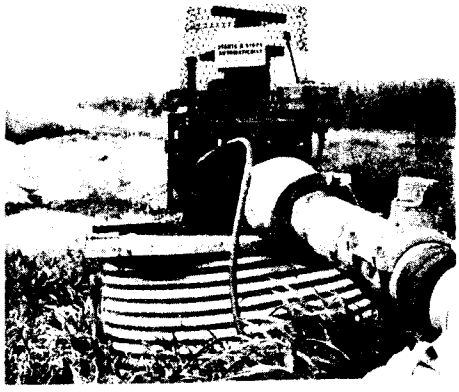

Figure 6. Check valves are used on both pumping plants when the reuse system is connected to the main pumping plant pipe line.

Return Pipe Lines and Accessories

Most reuse systems will require a return pipe line, either to another field or to the main supply ditch, gated pipe or buried pipe line. The sizes will vary according to the capacity of the reuse pump but probably will be a 4,6 or 8 inch diameter pipe. Pipe lines made frompplastic, concrete, cement asbestos, steel, plastic coated aluminum or fiberglass can be used.

The accessories needed are those which are normally used for pipe lines and pumping plants such as air relief, pressure relief and vacuum relief valves. If the reuse system is connected directly to a gated pipe or pipe line with the main irrigation supply, check valves will be needed on both the reuse and the main supply line pump.

Future reuse systems may be a multi-purpose addition to a farm- livestock operation. The return reservoir (probably dugout type) will be used as a waste disposal facility for the farm-livestock program. This could serve as a source of nutrients for the crops as well as a reuse system and waste disposal facility. Wastes could be pumped to the reuse reservoir and then be returned to an irrigated field.

Summary

Recirculating irrigation water with a reuse system consists of:

1. Runoff collecting system (field drains)
2. Storage reservoir
3. Pumping plant and controls, and
4. Return pipe line.

These reuse systems are being installed at a rapid pace for use with surface irrigation systems. They improve irrigation efficiency by:

1. Saving the runoff water
2. Providing the means of altering irrigation management practices so that deep percolation losses are reduced and the water is distributed more uniformly between the upper and lower ends of the fields.
3. Reducing labor required for irrigating.

The reuse system is adapted to the modern concept of automatic surface irrigation systems and will often be a necessity for automation of surface irrigation. Recommendations are suggested for the capacity of the storage reservoir and the pumping plant.

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